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Post-harvest Vapour Heat Shock Treatments of Fuerte Avocado Fruit

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ABSTRACT

Effects of three vapour heat shock treatments were evaluated for Fuerte fruit in the KwaZulu-Natal midlands over the 1995 harvest season. Some treatments increased post-harvest fruit longevity and reduced incidence of post-harvest physiological disorders. Negative effects of heat shock treatment were also established and heat-treated fruit showed increased sensitivity to cold chain breaks during cold storage. Indications are that future trials should use temperatures of lower than 48 °C since fruit treated at this temperature were problematic.

INTRODUCTION

Consumer resistance to chemical treatments to extend postharvest storage life has led to a marked increase in post-harvest heat shock research. Heat treatments have been used in a selection of fruit with several objectives:

- Control of insect pests (Klein & Lurie, 1992).
- Disinfestation of fungal and bacterial rots.
- De-sensitizing fruit to chilling injury.
- Reducing incidence of post-harvest physiological disorders.
- Decrease rate of ripening and prolonging shelf life.

Heat shock treatments have been shown to be beneficial in citrus (Kaiser *et al.,* 1995), mangoes (McCollum, *et al.,* 1993) and apples (Lurie, 1995). In addition, Woolf *et al.,* (1995) showed that heat treatments decreased chilling sensitivity and increased thermo-tolerance in Hass. Temperatures for heat shock treatments differ between the different fruits, and the oil-storing avocado fruit appears to be far more heat shock temperature sensitive than sugar-storing fruits, as lower temperatures are used for heat treatments in avocados. With increased production and exports worldwide there is an increasing need to develop new and more distant markets. This requires improved technology which will extend the post-harvest storage life of the avocado fruit. Previously, heat shock treatments were aimed at reducing post-harvest physiological disorders, including chilling injury and fruit browning. Heat shock treatment has been shown to increase time to softening in avocado fruit (Lurie, 1995), however, their interaction with long periods of cold storage remains to be thoroughly established for South African fruit.

The duration of heat shock treatments can be long (up to 3 days at moderate temperatures) or short (higher temperatures compensating for shorter heat exposure times). Longer exposure is required for microbial disinfestation (Lurie, 1996). This study investigated the effects of short heat shock treatments that would be more practical for the avocado industry than lengthy treatments. Hopefully future trials will find a time-temperature relationship that meets these constraints.

This study was undertaken as a continuation of previous work by Donkin (1995), where dry heat and hot water resulted in rind blemishing but vapour heat treatments showed promise. Because that study was exploratory, (testing effects of a wide range of temperatures on few fruits), results could not be statistically verified. In addition, heat shock treatments were performed only once during an entire harvest season. Consequently, the effects of fruit maturity were not taken into account.

MATERIALS AND METHODS

Fruit was obtained on five harvesting days during the season:

- 30/05/95
- 23/06/95
- 20/07/95

And many fruit ripened while in cold storage. Internal disorders

- 27/07/95
- 04/08/95

The first batch of fruit was supplied by Everdon Estate (Howick), and the other four batches were obtained from Cooling Estate (Wartburg), a marginally warmer climate. Heat shock treatments were administered in a container equipped with a Paxon Electrotherm® which recirculated warm air of high relative humidity (RH > 90 %). Two cartons, each with 16 fruits (236-305 g), were subjected to the following vapour-heat treatments:

- 5 min at 48 °C.
- 10 min at 48 °C.
- 90 min at 40 °C.

Following vapour-heat treatment, fruits were placed in cold storage at 3,5 °C for 28 days. On removal, firmometer readings were taken (Swarts, 1981) and then the fruits were allowed to ripen at ca. 20 °C. When ready to eat, fruits were rated externally and internally for defects. Time to ripening was also noted.

Unfortunately, power failures and refrigeration problems occurred during cold storage of fruit harvested on the third and fourth harvest dates, and results were interpreted accordingly.

RESULTS AND DISCUSSION

Vapour heat showed potential in increasing post-harvest life of avocado fruit in cold storage. Furthermore, benefits of heat treatment are reflected in lower (i.e. firmer fruit) firmometer readings on removal from cold storage, indicating that such fruit would arrive at export markets in a firmer condition than untreated fruit. The proviso, however, is that heat-treated fruit requires continuous cold during storage. When refrigeration failed (while fruit harvested on 20/07 and 27/07 were in cold storage), heat-treated fruit showed higher firmometer readings (i.e. were softer) on removal from cold storage, and ripened more rapidly than those that had not been heat treated (figures 1 and 2).

The effects of vapour-heat on fruit from Cooling Estate were variable but had less effect towards the end of the season. At Everdon Estate, vapour heat had very little effect ($P > 0,05$) on fruit harvested on 30 May 1995. It is possible that fruit maturity and thus oil content were responsible for this phenomenon.

Vapour heat showed benefits in fruit harvested on 23 June 1995. Firmometer readings on removal from cold storage were significantly ($P < 0,05$) lower (firmer) for all treatments (figure 1) by 142 (± 46) and ripening time was similarly increased by 2,8 days (± 0,99). Internal fruit quality of treated fruit was superior since the incidence of physiological disorders was higher in control fruit (figure 3). Differences in external defects between control and treated fruit were marginal (figure 4).

Fruit harvested on both 20 July and 27 July was affected by increases in temperature during refrigeration. This affected fruit quality particularly in vapour-treated fruit. On 20 July firmometer readings were significantly ($P < 0,05$) higher by 356 (± 136), were not adversely affected (as would be expected).

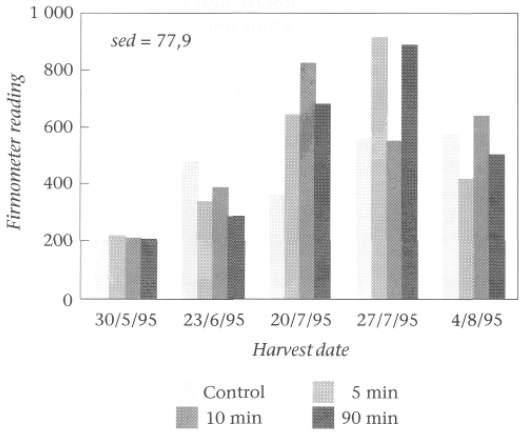

Figure 1
Effect of vapour heat on fruit firmness after removal from cold storage

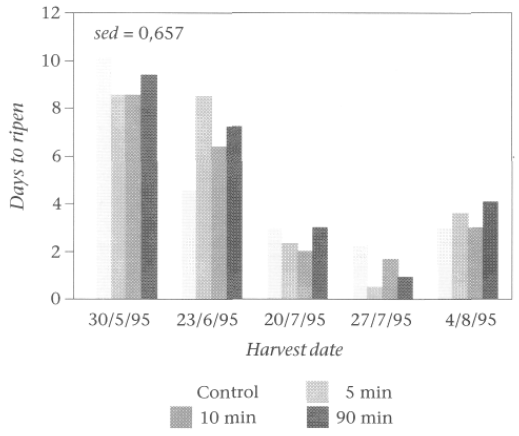

Figure 2
Effect of vapour heat on time to ripening after removal from cold storage

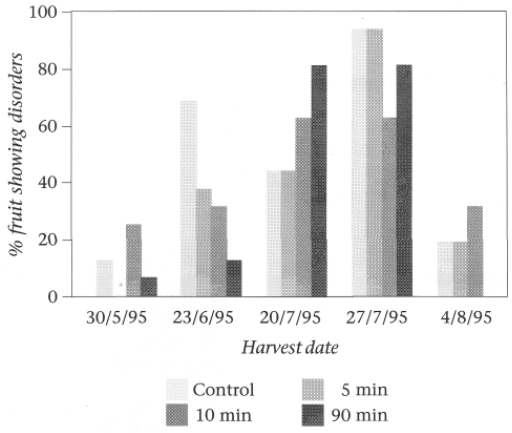

Figure 3
Effect of vapour heat on incidence of internal defects of fruit

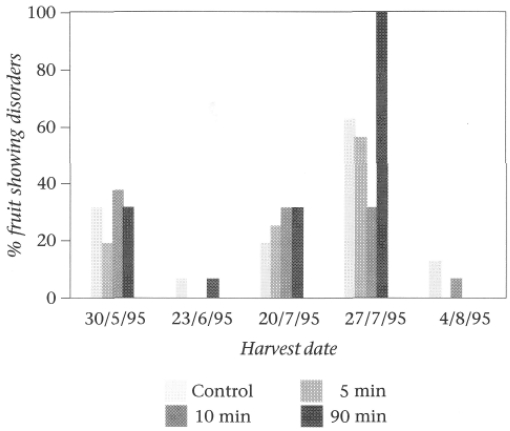

Figure 4
Effect of vapour heat on incidence of external defects of fruit

On 4 August 1995 only treatment 2 resulted in fruit having firmness of similar or lower (firmer) firmness after cold storage, but ripening time was marginally increased for all heat treated fruit. This suggests that vapour-heat treatments prolong storage life after cold storage, a further benefit. Furthermore, it is also likely that vapour-heat shock treatments were too severe for more mature late harvested fruit, with higher oil content.

Variability determined by statistical analysis indicated that the response of fruit to vapour heat at these temperatures was not optimal. Consequently, different treatments should be investigated. In particular, 48 °C is believed to be too high for avocados. Furthermore, inconsistency of treatments throughout the harvest season indicates that fruit maturity plays an important role in heat shock treatment, and this will also have to be taken into consideration in future trials. Since no single treatment was consistently superior to others, it is possible that vapour-heat treatments, when used commercially, will have to be modified according to various pre-harvest parameters. Variability in results across the harvest season indicate that pre-harvest orchard factors are most important in determining post-harvest fruit quality.

It is also possible that the site influences the fruit response to heat shock treatment, since differences were marked between Everdon Estate and Cooling Estate respectively (figures 1 and 2). In addition, results for vapour-heat treatments need to be tested for consistency in both 'on' and 'off years as fruit quality appears to vary.

CONCLUSIONS

Vapour-heat treatments show potential for increasing fruit quality in exported fruit. While some researchers have shown vapour heat to have potential for desensitizing fruit to chilling injury, thus enabling longer cold storage because of lower temperatures, the results of this trial indicate additional advantages, including a longer cold post-storage shelf life. Increased ripening brought about by optimal heat shock treatments in conjunction with optimal storage temperatures make it likely that more distant markets may be explored in the future. A cautionary word is, however, necessary. Where the

cold chain was broken, treated fruit quality was worse than the control.

Finally, minimum refrigeration temperatures should also be identified, since the incidence of chilling injury was not noted, even in control fruit stored at 3,5 °C, a temperature which has been shown to induce chilling injury symptoms in the port (Donkin, 1995).

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REFERENCES

DONKIN, D. 1995. *Some Aspects of Cold Storage of Fuerte Avocados* (Persea Americana *Mill.) grown in the Natal Midlands.* Unpublished M.Sc. Agric, thesis. University of Natal, Pietermaritzburg.

LURIE, S., FALLIK, E. & KLEIN, J.D. 1996. Heat treatment to extend storage and fungal rots. *Abstracts of the VI Congress of the South African Society for Horticultural Sciences,* Midrand, Gauteng, p. 39.

LURIE, S., KLEIN, J.D., HANDROS, A., ACKERMAN, M. & ZAUBERMAN, G. 1995. A pre-storage heat treatment as a means of delaying avocado fruit ripening and the development of low temperature injury. *Abstracts of the World avocado congress III.* Tel-Aviv, Israel, p. 123.

KAISER, C., WRIGHT, M.J., BARD, Z.J. & WOLSTENHOLME, B.N. 1995. Pre-storage vapour heat effects on grapefruit *(Citrus paradisi* Macf.) 'Star Ruby' fruit stored at low temperatures. *Proceedings of the VIII Congress of the International Society of Citriculture.* Sun City, South Africa. In press.

KLEIN, J.D. & LURIE, S. 1992. Heat treatment for improved postharvest quality of horticultural crops. *HortTechnology* 2: 316 - 320.

MCCOLLUM, T.G., D'AQUINO, S. & MCDONALD, R.E. 1993. Heat treatment inhibits mango chilling injury. *Hort Science* 28: 197 - 198.

SWARTS, D.H. 1981. Fermometer ondersoeke by avokados. *South African Avocado Growers' Association Yearbook* 4: 24 - 26.

WOOLF, A.B., BALL, S., WHITE, A., SPOONER, K.J., WATKINS, C.B., BOWEN, J.H., LAY-YEE, M. & FERGERSON, I.E. 1995. Post-harvest responses of avocado to high temperature treatments. *Abstracts of the World Avocado Congress III,* Tel Aviv, Israel, p. 122.